II. *Several Experiments touching the ſeeming Spontaneous Aſcent of Water.* *By* Mr. Fr. Hauksbee, *F. R. S.*

EXPERIMENT I.

THE ſeveral Experiments, which already hath been made in relation to the Spontaneous Aſcent of Water in ſmall Tubes, not only by my ſelf, but ſeveral others, with much the ſame ſucceſs, gave me the occaſion of thinking, whether the Figure of the Veſſel might, or might not, contribute to the oddneſs of the Appearance. And to give my ſelf that Satisfaction, (an Account of which I thought would not be unacceptable to the Society) I proceeded as follows.

I procured a Couple of Glaſs Planes, about ſeven Inches long, and one and a half broad; theſe Planes were part of a broken Looking Glaſs; and notwithſtanding when clapt together, they ſeem'd to touch one another in ſo many parts, yet when they came to be immerſed in a Liquid, the Liquid would aſcend between them; but ſo thin and colourleſs it was, that it could not without difficulty be diſcerned, but upon the ſeparation of them, when they would be found wet on all their parts: therefore to make it more obvious, I put a ſmall piece of thin Paper on each corner; by which means, when laid one on the other, they became ſeparated by ſuch a diſtance, as is equal to the thickneſs of the Paper. In this manner I plung'd one end under ſome ſtrongly ting'd Liquor; where it no ſooner arriv'd, but the Water run (but

(but not with that Velocity as in a ſmall Tube) gradually, ſometimes higher in one part than in another, ſhooting it ſelf very pleaſingly into Branches divers ways, and ſo would continue till it had arriv'd to its greateſt height; but that would be according to the diſtance the Planes were plac'd aſunder: for if, inſtead of one, two pieces of Paper were laid on each corner of the Planes, the Water then would not aſcend ſo high between them, as when they were ſeparated only by a ſingle one. And then, if the Planes were any ways declin'd, the Water would ſtill ſpread it ſelf farther and farther, agreeable to the degree of Declination: and this on ſeveral tryals ſucceeded much the ſame.

EXPERIMENT II.

Having ſeen the ſucceſs of the former Experiment in the open Air, I was willing to try what appearance it would afford in *Vacuo*; accordingly I fixt the two Planes ſo to a Braſs Wire, (which paſt thro' the Cover of a Receiver) that I could make them deſcend at pleaſure. In this manner, with a Diſh of ting'd Liquor, I convey'd them within the Receiver; which having plac't on my Pump, I proceeded to exhauſt its contain'd Air, which the Gage, in a little time, diſcover'd to be pretty nicely done. Then I plung'd the Planes (ſeparated by Pieces of thin Paper as before) into the Water, where, as in the open Air, it aroſe between them; only with this difference, that there appear'd more Intervals, or Spaces, between the Branches of the aſcending Liquid, than in the former Experiment: but when I came to let in the Air, thoſe Intervals vaniſh'd, and an intire Body of the Liquid ſucceeded; yet the exact form of the upper parts of it remain'd unalter'd.

EXPERIMENT III.

By the foregoing Experiments I found, that neither the Figure of the Veſſel, nor the Preſence of the Air, did any ways aſſiſt in the Production of the forementioned Appearance. To try therefore whether a quantity of Matter would help to unriddle the Miſtery; I produc'd two Tubes of an equal Bore, as near as I could, but of very unequal Subſtances, one of them being at leaſt ten times the thickneſs of the other; yet when I came to plunge them into the premention'd Liquid, the Aſcent of it ſeem'd to be alike in both. Now ſince the form of the Veſſel, the preſence of the Air, or the quantity of Matter that compoſes the Veſſel, do not any thing contribute to the Production of the Phænomenon, it may not be amiſs, to inquire a little into the Nature and Property of ſome other Body, that operates with equal Vigour, under the prementioned Circumſtances; and by a Compariſon of one with the other, we may at length arrive nearer to account for the ſame.

What I ſhall now uſe to compare with theſe Experiments, is the Magnet.

Firſt, A Magnet of any form will attract Iron.

So by the firſt Experiment, the Figure of the Veſſel ſeems no ways to contribute to the Aſcent of the Water.

Secondly, The Magnet is no ways leſſen'd in its vigour of Attraction, even in ſo thin a Medium as a *Vacuum*.

So by the ſecond Experiment we find the preſence of the Air to be no ways neceſſary to aſſiſt in the Aſcent of the Water, in ſmall Tubes, or between the Planes.

Thirdly,

Thirdly, The Magnet, as ſuppoſe one of a Pound weight, that will take up or ſuſpend a piece of Iron of the like weight, and no more, (ſuppoſing it to be in every part of equal vertue) when ſeparated and broke into a number of ſmall parts, (imagining them not to weigh above half a Grain each)and theſe dreſt,and Arm'd according to Art, will then be capable to ſuſpend fifty, nay perhaps a hundred times more the weight of Iron amongſt them now ſeparate, than they could when all of one Maſs; which appears to me, that the Attractive Quality of the Stone ſeems to be increas'd in Proportion as its Superficies is to its Bulk of Matter.

So by the third Experiment, I found that the Quantity of Matter, that was us'd to compoſe one Veſſel more than the other, ſignify'd nothing to the Aſcent of the Water, which ſeem'd wholly to depend on the largeneſs, or the ſmallneſs of their Cavities, as to the height it would ariſe in them; and as their Cavities are leſſen'd, ſo the Diſproportions of their inward Surfaces to their Cavities are increas'd.

And as the Magnet, when ſeparated into the prementioned number of ſmall Parts,will attract more than when united in one, and is no more than ſeparating or working the prementiond thick Body of Glaſs into a number of ſmall Tubes, that is multiplying the Surfaces; the Water then would ariſe in each of them ſingly, as it would when all in one Body, its Cavity being the ſame with the others; by which means, the quantity of Water aſcending in them is augmented from the ſame Quantity of Matter.

To conclude: There ſeems to be ſuch an agreeableneſs of the Qualities or Diſpoſitions of one with the other, that I ſee no reaſon why the Facts proceed not from one and the ſame Cauſe; for as the inward Surfaces of the Tubes are made ſmaller and ſmaller, ſo the Power of their Attraction (as is viſible by the higher

Aſcent of the Water in them) is greater and greater, and is moſt demonſtrable by the Experiments of the Planes; for their inward *Area* being always the ſame, ſo that as they are placed nearer and nearer to each other, the Cavity or Space between them becomes leſs and leſs, and conſequently the Diſproportions are increaſed, whereby the Power of their Attraction is augmented.

EXPERIMENT IV.

This Experiment I take to be very Analogous to thoſe lately made on the ſeeming ſpontaneous Aſcent of Water between Glaſs, Marble, and Braſs Planes, as alſo with thoſe made in Capillary Tubes; ſince it ſeems to proceed from the ſame Principle, and ſubject to the ſame Laws, as appears by matter of Fact; which take as follows. I took a Glaſs Tube about 32 Inches long, the Diameter of its Cavity near three quarters of an Inch: This, when I had ty'd a Piece of Linnen Cloth at one end, (to prevent the Aſhes from falling out) I proceeded to fill with Aſhes at the other: the Aſhes were ſifted thro' a pretty fine Searſe. At every ſmall Portion I put in, I ramm'd them ſtrongly down with a Rammer, whoſe Baſis was very little leſs than the Bore of the Tube; by which means, I laid, or rather crouded them as cloſe together as poſſible. When the Tube was become full, I ty'd over that end of it by the Neck a ſmall and limber Bladder, having firſt expreſt all the Air out of its Body, in order to receive that Air, which I expected would be forc'd thro' the Aſhes upon the Aſcent of the Water. In this manner I plung'd the end of the Tube, to which I had ty'd the Linnen, (as it was,) under the ſurface of Water in a Glaſs, and found the Waterpreſently begin to Aſcend in it: It aroſe a pretty pace at firſt; for in 16 Minutes time it had aſcended near an Inch and three quarters: but as it aroſe higher, ſo its Progreſs

Progreſs became ſlower; for at the end of 24 Hours, the Water had attain'd but to 16 Inches; the Bladder, at the top being near half fill'd with that Air which had deſerted the Aſhes as the Water aſcended in them. At the ſame time I found the upper part of the Tube, to which the Bladder was ty'd, to be crack'd round, and ſoon after drop'd off. However I had the Satisfaction deſir'd. And ſo continuing the Experiment, I found at 24 Hours diſtance from the laſt Obſervation, the Water had aſcended in the Aſhes 6 Inches higher, which was very diſcernible by the change of Colour it gave them, diſtinct from thoſe that were dry.

Again, At the like diſtance of time from the laſt notice, the Water had ariſen 4 Inches and a half, and ſomething better. On the 4th day, at the uſual time of Obſervation, it had aſcended 3 Inches higher: and when the following 24 Hours were finiſh'd, the Water reach'd within half an Inch of the top, by its aſcent of 2 Inches. About 10 Hours after, it had compleatly reach'd the Extremity of the Tube. Then deſiring to know what Quantity of Water the Aſhes had Abſorb'd, I weigh'd a Glaſs of Water nicely, part of which I Pour'd into the Glaſs, in which the Tube had all along been kept, till it reach'd the Mark the Surface of the Water ſtood at, when the Tube was firſt plung'd into it; and found the Quantity to be equal to the weight of 1792 Grains, which is nearly the Bulk of 7 Cubical Inches; the Capacity of the whole Tube, in which it aroſe, was equal but to about 13 Inches of the ſame denomination. Now this Experiment to me ſeems ſurpriſing enough from the following Obſervations.

Firſt, That the Water not only aſcended in the Aſhes, as between the premention'd Planes, and in the ſmall Tubes, contrary to its Natural Gravation; but with ſuch a Power too, as to force, and put to flight pretty ſtrongly impriſon'd Air, which was contain'd in the Interſtices of the Ramm'd Aſhes.

Secondly, That the removal of this Impriſon'd Air could not be done without a Power ſurmounting its Reſiſtance, which muſt be great, ſince upon endeavouring to force Air thro' the Body of Aſhes by the ſtrength of my Breath, when the Tube was not above half fill'd, it prov'd unſucceſsful. Not but that I believe, if the ſame force had been continu'd for ſome time, it would have found its way through.

That the Water aſcends faſteſt at firſt, when there is a larger quantity of Interſtitial Air to remove, (if I may call it ſo,) than when the Column of the dry Aſhes grows ſhorter, by the higher Aſcent of the Water in them.

Fourthly, That notwithſtanding the Tube was rammed as full as it could with Aſhes, yet their Interſtices were ſo many, as to receive, or imbibe another Body, equal in bulk to above half the Content of the whole.

Fifthly, That the Water aroſe, not only in the Aſhes adjoyning to the inward Surface of the Tube, but equally in the whole Body of it, as I found upon Examination.

Sixthly, That the Air lodg'd in the Interſtices of the Aſhes, was protruded thro' them as the Water aſcended, was manifeſt by the Intumeſcence of the Bladder: And notwithſtanding the Accident of the Bladders falling off, I cannot but conclude, that the Quantity of it muſt be equal to the like bulk of Water which ſupplyed its place.

I repeated the ſame Experiment in *Vacuo*, in a Tube much about the ſame Diameter of the other, but not above 10 Inches in length: This Tube, being fill'd with Aſhes as before, was plac'd in *Vacuo*, where it remain'd ſome time, to give liberty for the Air contain'd in them to get away. Then Plunging the lower end of the Tube under ſome Water, I found (as I expected,) that the Water aroſe faſter in the Aſhes in that Medium, than in Common

Common Air; for in about 4 Hours time, it had reach'd the Extream of its height; which plainly ſhews, that the Preſence of the Air is ſo far from being neceſſary in the Production of this old Phænomenon, that it is a manifeſt Impediment to it.

A Continuation of Experiments, touching the ſeeming Spontaneous Aſcent of Water, or other Liquids. *By Mr.* Fr. Hauksbee, *F. R. S.*

THE Aſcent of Water in Capillary Tubes has been taken notice of ſome Years ago, but that it ſhould ariſe between two Glaſs Planes, whoſe Sides lie open to the Air, I had not ſo much as received a Hint of it before I firſt diſcover'd it. And I find that this *Phænomenon* is not to be ty'd up to Glaſs Bodies alone; for Stone, or Braſs, and, for ought I know, moſt other Bodies that have ſmooth Surfaces, or that their Surfaces may become nearly Contiguous to one another, may give the like Appearance; as is plain by the following Experiments. I procur'd a pair of Marble Planes, that were Ground as true as the Workman could make them: Theſe when I had joyn'd together dry, without any thing between, I plung'd the Edge of them about a quarter of an Inch under the Surface of the Water, and continued them ſo for ſome Minutes of time: then taking them out, I found I could not eaſily part them without ſliding them one from off the other; which when I had done, 'twas eaſily diſcoverable how far the Water had made its way between them, which, upon divers tryals, I have found different; but at all times, when I had newly rubbed over the Planes with Wood Aſhes, the Water would aſcend higheſt. Now whether the ſmall Duſt of the Aſhes adhering to the Planes may contribute any thing towards

towards it; or that they better clear them from an Oily or Viſcous Matter, that may be communicated to them from our Hands, I cannot yet determine: However, whatever the occaſion is, the Matter of Fact is true. Then I took a pair of round Braſs Planes, and ordered them as before; the Succeſs of which was very agreeable with the former.

There is one thing I forgot to take notice of in a former Experiment; which is the Aſcent of Spirit of Wine, or Oyl of Turpentine between two Glaſs Planes, without any thing to ſeparate them. It cannot be imagined but that theſe Planes muſt touch each other in a multitude of Parts; yet for all that, and notwithſtanding they are held forcibly together, the Spirit of Wine will inſinuate, and aſcend ſeemingly in an intire Body, between all the contiguous Parts of them, as before and after their Separation nothing appears to the contrary.

To the prementioned Experiments give me leave to add what I have ſince obſerved, in plunging the Planes in Spirit of Wine, Oyl of Turpentine, and common Oyl: That all theſe different Fluids aroſe between as the tinged Water; only with this difference, the common Oyl very ſluggiſhly; it was near an Hour ariſing ſo high between them, as the other Liquids would in leſs than half a Minute. They all aroſe in an intire Body from ſide to ſide of the Planes, without thoſe Intervals or Spaces, which generally happen on the Aſcent of the Water. I likewiſe too a couple of round Glaſs Planes, and having laid them one on another, without Paper, or any thing elſe between to keep them ſeparate; In this manner I plung'd one edge juſt under the Surface of the tinged Liquor, and found the Water almoſt Inſtantly had reach'd the Extreams of them in all Parts: By which we find, that the Water not only aſcends directly upwards, but runs ſideways, obliquely, or in any direction.